STRUCTURAL ANALYSIS OF POLYMERIC SCAFFOLDS BY MICRO-CT

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Introduction

The use of porous structures as tissue engineering scaffolds imposes demands on structural parameters such as porosity, pore size and interconnectivity. For the structural analysis of porous scaffolds, micro-computed tomography (μCT) is an ideal tool. μCT is a 3D X-ray imaging method that has several advantages over scanning electron microscopy (SEM) and other conventional characterisation techniques:

- visualisation in 3D
- quantitative results
- non-destructiveness
- minimal sample preparation

Methods

For demonstration of the technique, μCT scanning was performed on three polymeric scaffolds fabricated by different methods:

A. Salt leaching from photopolymerised poly(D,L-lactide)
B. Foaming of poly(D,L-lactide) with supercritical CO_2[1]
C. Fused deposition modeling (FDM) of PEOT/PBT copolymer[2]

A General Electrics eXplore Locus SP was the μCT-scanner employed. To calculate porosity, average pore size and pore size distributions, the GE Bone Analysis Tool for MicroView was used.

Results & discussion

Figure 1 shows a photograph and a 3D-rendered image of the regular-patterned FDM scaffold.

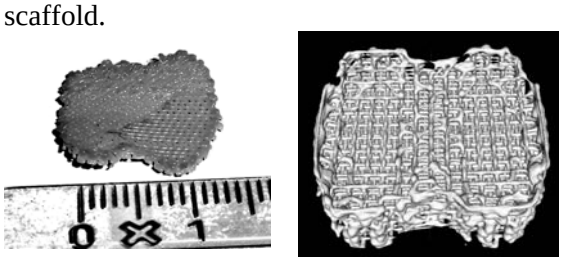

Figure 1: Photo and 3D-rendered image of fused deposition-modeled scaffold

Table 1 shows the values for porosity and average pore size for the different scaffolds. Figure 2 shows their pore size distributions. The smallest detectable pore size is 20 μm, which is smaller than the smallest desirable pore size for tissue engineering purposes.

Table 1: Values for porosity and average pore size for the different types of scaffolds

scaffold	A. salt	B. CO_2	C. FDM
porosity	75%	62%	69%
pore size	78 μm	60 μm	358 μm

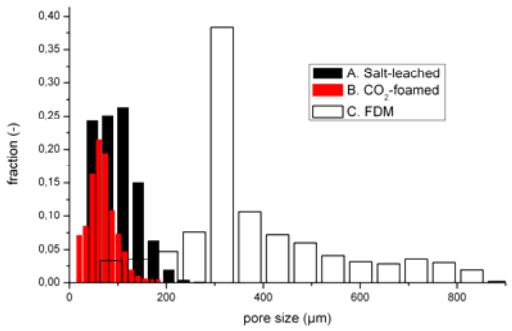

Figure 2: Pore size distributions of the different types of scaffolds

Since scaffold C is fabricated with a rapid prototyping technique, the pores are larger and the distribution in pore size is narrower than those of scaffolds A and B, which are fabricated with a random-porosity technique. Pore interconnectivity and (cell) accessibility are also important; currently software is being developed to calculate these parameters from the μCT scans.

Conclusion

Micro-computed tomography (μCT) is a powerful tool in the structural analysis of porous scaffolds. It offers the possibility to visualise the 3D structure and characterise it in a quantitative way.

References

[1] MMcg. Silva *et al*; Biomaterials 27(35); 5909-5917; **2006**
[2] L. Moroni *et al*; J Biomed Mat Res A 75A (4); 957-965; **2005**